WHAT STUDENTS ARE TELLING US ABOUT WHY THEY LEFT THEIR ICT COURSE

Madeleine R. H. Roberts
Faculty of Informatics
University of Wollongong
NSW 2522, Australia
mrhr01@uowmail.edu.au

Tanya McGill
School of Information Technology
Murdoch University
Murdoch WA 6162, Australia
t.mcgill@murdoch.edu.au

Tony Koppi
Faculty of Informatics
University of Wollongong
NSW 2522, Australia
tkoppi@uow.edu.au

ABSTRACT

Student attrition is an issue of particular concern in the field of ICT because the industry faces staffing shortfalls. The study described in this paper provides further understanding of the causes of attrition from ICT courses by exploring the reasons students give for leaving their ICT courses. An online survey of early leavers from four Australian universities was conducted. The results show that many factors can contribute to the attrition of ICT students, and that for many students it is a combination of issues that leads to their withdrawal. Only a relatively small number of ex-students had experienced serious life events that necessitated their withdrawal. It was much more common for the participants to cite reasons associated with the university environment, the teaching of their ICT course, and their inability to combine their studies with other commitments. Recommendations are made to address issues that could be mitigated by university action.

Keywords

Student attrition; student retention; ICT education

1. INTRODUCTION

The use of information and communication technology (ICT) now underpins the vast majority of work and business life in the developed world and this trend is also increasing in the developing world (ITU, 2010). ICT is now integral to our personal and work communications, our finances, education, health care and entertainment. As such, the role of ICT professionals is vital in maintaining our current lifestyles. It is surprising, therefore, to find that there is a shortage of ICT professionals in most developed countries (Gras-Velazquez et al., 2009; S. Lewis et al., 2007). In Australia, for example, the Australian Computer Society identified a shortfall of 28,488 ICT staff for 2008, and projected a massive increase on this over the following decade (ACS, 2008). More recently it was reported that there were 30,000 ICT positions unfilled in Germany (Telecompaper, 2010) and e-skills UK (2011) has predicted that over half a million new ICT professionals will be needed in the next five years Unfortunately, this abundance of opportunities may already be wasted since there are not sufficient people trained to take their places.

There appear to be three main causes for this shortfall of ICT professionals:

1. the retirement of ICT professionals who are part of the baby boom generation has reduced the available pool (Crisp et al., 2009).
2. a lack of students commencing ICT training, particularly at the degree level, has reduced the number of potential future ICT professionals (Computing Research Association, 2008; Cory et al., 2006; Granger et al., 2007; S. Lewis et al., 2007).
3. high levels of attrition from ICT training has compounded the problem (Bailey & Borooah, 2007; Marks, 2007) .

The first of these causes seems inevitable and the second is a complex, long-term problem which requires a considerable shift in society's perceptions of ICT as a profession (Craig et al., 2002; Koppi & Naghdy, 2009) from one inhabited by "geeky guys" (Frieze, 2005) to one that garners admiration and respect. However, the third of these reasons could be addressed if we were able to identify the causes of attrition. This study aims to understand the factors contributing to attrition from ICT university degrees by exploring the reasons students give for leaving their ICT courses. To achieve this goal an online survey was conducted to determine what

factors in a student's personal life, or in their experience of attending university, influence their decision to abandon their study of ICT.

Attrition is the central theme of this paper and there are numerous definitions of its meaning from Seidman's simple "diminution in numbers of students resulting from lower student retention" (2005 p. 92) to Hinton's (2007) comprehensive identification of nine forms of attrition. .In this study the term attrition is used to indicate the loss of students from ICT courses either because: they leave the institution altogether or because they transfer to another non-ICT course at the same institution. It is thus used at both the institutional level and the course level.

ICT courses have been identified as having exceptionally high attrition rates across the developed world. In an Australian study, Marks (2007) identified information technology as having the largest attrition rate of identified fields of study with approximately one third of students leaving. Similarly a UK study by Bailey and Borooah (2007) found a 28% attrition rate. In comparison, medicine and law had attrition rates of less than 5%, and education approximately 14%.

Researchers agree that attrition from tertiary educational institutions is expensive and wasteful (Bailey & Borooah, 2007; Johnes & McNabb, 2004; McMillan, 2005; Tinto, 1993; Yorke, 1998). So, not only is attrition from ICT degrees a problem for the ICT industry but it also has implications for the universities that teach ICT as they depend upon student enrolments and continuation for funding (Andrew et al., 2007; Hinton, 2007; Tinto, 1993) and for the students who, having withdrawn from their enrolled degree, incur significant costs from which they gain no benefit if they leave before completion.

Numerous studies have been undertaken to establish the reasons for attrition from tertiary education in a number of countries around the world. Many of these have focused on only one reason at a time, such as financial aid (Stater, 2009), the effect of boredom (Mann & Robinson, 2009) or the choices made by students with dependent children (Marandet & Wainwright, 2009) while others have attempted to cover a spectrum of reasons. Hovdhaugen (2009), for example, focused on student background characteristics as well as their goals and commitments once enrolled at university to determine the causes of both withdrawal from, and transfer between, university courses. The study found that pre-entry attributes (gender, age, social background and prior academic achievement) could explain withdrawal more effectively than the educational goal or the motivation of the student, while these largely explained the reasons for transfer. The work of Bennett (2003) and Bailey and Borooah (2007) has also highlighted the role of personal characteristics in attrition and both studies confirmed the importance of financial hardship,

Early models such as those proposed by Tinto (1975) and Bean (1980) have proved useful in understanding attrition, and have been extended by various authors to better predict and understand the phenomenon (e.g. Beekhoven et al., 2002; Braxton et al., 2000; Cabrera et al., 1993). For example, Cabrera et al. (1993) investigated whether Tinto's Student Integration Model and Bean's Student Attrition Model could be merged. As well as confirming relationships among the commitment, social and academic integration factors they also found support for the effect of external factors such as encouragement from friends and family on the student's commitment to the institution. Beekhoven et al. (2002) showed that a greater amount of the variance in academic progress could be explained if integration and rational choice theories were combined.

In addition to studies focussing on attrition across a range of disciplines, there have been a number of studies focussing on attrition in ICT degrees. Whilst ICT faces many of the same issues as other disciplines, factors such as the low numbers of female students enrolling, and reports of higher female attrition rates (Barker et al., 2009) differentiate it. There is some evidence that these are linked, as an increase in the proportion of females has been shown to reduce attrition (Cohoon, 2001). Previous research has shown that, while female ICT students do not appear to differ from male students in terms of their academic ability to understand the material, they lack confidence in their ability to do so (Beyer et al., 2003; Cohoon, 2007). They may also have had less previous ICT experience (Cohoon & Aspray, 2006).

Other studies specific to attrition in ICT have explored factors such as technical ability, computing resilience (T. L. Lewis et al., 2008), prior experience in programming and use of collaborative learning experiences in the classroom (Barker et al., 2009). Prior experience in programming was found to be an important predictor of intention to continue in computer science, however, technical ability appeared to be less important than soft skills (T. L. Lewis et al., 2008).

Weng, Cheong and Cheong (2010) developed an information systems student retention model based on the models of Tinto (1975) and Bean (1980). They found the three most important factors in determining information systems student's continuance to be self-efficacy, goal commitment and academic integration.

The outcomes of these many studies suggest that attrition is influenced by both individual characteristics of students and the educational environment. Some factors apply across many disciplines, and some are more discipline specific. While some factors, such as student ability and financial pressures, are beyond the control of the institution, others, such as collaborative learning experiences in the classroom and the amount of contact students have with faculty members, can be influenced by universities. This paper attempts to understand the factors contributing to attrition from ICT university degrees by exploring the reasons students give for leaving their ICT courses, and makes recommendations to institutions based on these reasons.

2. METHOD

Four Australian universities from different states were involved in the study. In order to identify those students who were early leavers from their ICT degrees or from the universities themselves, the Registrars at the four universities identified students who had transferred from an ICT degree to an unrelated degree at the university, or who had left the university altogether, between 2005 and mid 2010. These 2,868 students were then sent an email or letter requesting their participation in an online survey. The questionnaire took approximately 15 minutes to complete. Completion of the questionnaire was voluntary and all responses were anonymous.

The online survey was created in SurveyMonkey and consisted of three main types of questions. Participants were asked a number of questions that captured demographic and background information such as age, gender, marital status, ethnicity, whether they were a domestic or international student, their parents' gross annual income and the type of ICT degree in which they had been enrolled. There was also a series of questions about their enrolment and early participation in the course. These included original enrolment status, whether they had enrolled late, and whether they had participated in orientation programs and other activities organised by the university and faculty.

The rest of the survey questions were designed to explore the reasons why participants had withdrawn from their ICT course. These questions were presented in four sections. The first section contained questions to determine whether their main reason for leaving their degree was due to personal reasons, or whether it related to something about the course, or whether it was a combination of these. The second section contained questions covering experiences of the university itself (see Table 1 – University Experience Reasons - for a list of these items). The third section included items about their course including items relating to academic preparedness, the way the course was taught and run, and aspects of the teaching and learning environment (see Table 2 - Course Experience Reasons - for the items). The fourth section asked about life experiences such as chance events, health, finances, travel, accommodation and work (see Table 3 - Life Experience Reasons - for the items). The items in the second, third and fourth sections were presented as negative statements summarizing possible reasons for attrition (e.g. 'I couldn't get help when I needed it') and respondents were asked to rate their agreement with each statement on a 5-point Likert scale ranging from 'Strongly Disagree' to 'Strongly Agree'. These groups of questions were designed to cover the range of events, experiences and outcomes that may have led each respondent to make the decision to leave their ICT degree.

3. FINDINGS AND DISCUSSION

3.1 Participants

A total of 154 ex-ICT students (18.8% females and 81.2% males) completed the survey, giving an response rate of 6% for those students who were able to be contacted, as approximately 10% of letters and emails to potential participants were unable to be delivered. The relatively small proportion of female respondents is consistent with the numbers of women studying ICT at the universities involved (Department of Education Employment and Work Relations, 2011), and with the literature on the notably low female participation in ICT education at a tertiary level in Western countries (Cory et al., 2006; Craig et al., 2007; S. Lewis et al., 2007; Ogan et al., 2006; Siann & Callaghan, 2001). The majority of the participants had studied full time (74%) and were domestic students (92.7%). The low proportion of international students (7.3%) reflects the difficulty in maintaining contact details for international students once they leave the country. Participants ranged in age from predominantly school leavers (41.5%) to a small proportion (1.3%) who were between 46 and 55 when

they commenced their studies. It was the first attempt at university study for 75.2% of the students, and the degree they were studying was their first choice for 76.6% of respondents.

The majority of the participants had attended orientation activities (72.3%), and 32.4% had attended functions organized by the university and/or school. It was interesting to note that many of the students who had not attended functions indicated that either none were organised, or that they were not aware of any. Only one participant had missed the start of the course.

3.2 Reasons for Attrition

The literature has identified many factors that may be associated with attrition. When participants were asked if their main reason for leaving their degree was due to personal reasons, reasons associated with the course itself or both, the majority of respondents indicated that both personal and course issues had influenced their decision (55.2%). For example:

> *"Two Reasons. A) Dad died. B) Course wasnt what i expected when i enrolled" Male, 24, CompSci.*

For 26% of participants the main reason was personal. The following quote is from a student who had financial issues:

> *"I had to work more to pay rent/bills which negatively impacted my study. Centrelink allowances are too low to live on and (in my case at least) were cut off if I elected to do part time study" Male, 21, CompSci.*

For 18.8% of participants the main reason was course related. The following quote illustrates the frustration that led to one student withdrawing for course related reasons:

> *"The course content material was paced relatively quickly, and i wasnt able to pick up the programming languages fast enough, i lost interest in the course as the programming languages changed frequently and would have to start back at 'square one' almost every time the language would change" Male, 19 CompSci/GamesTech.*

Table 1 below presents the responses to reasons for attrition that relate to the university environment. The most frequent response was that there were too many distractions preventing them from concentrating on their studies (40.5% agreed or strongly agreed). Other notable reasons also included the challenge of organising a timetable with no clashes (27.6% agreement) and getting help when needed (26.7% agreement). The difficulties some students experienced in obtaining help are illustrated by the following quote:

> *"….specifically asked admin staff, or teaching staff for help and was turned away on every occasion, or told to look at a website, neither of which provided the slightest bit of help…" Male, 18, IT.*

The issue of least concern was the possible security risk associated with attending evening classes (4% agreement). Although security concerns have often been mentioned in the literature as a reason for attrition (Marginson et al., 2010), the vast majority of ICT students and participants in the online survey were male and domestic, and perhaps because of this have not been so influenced by this issue.

University Experience Reasons	Total Num.	SD %	D %	N %	A %	SA %
There were too many distractions preventing me from concentrating on my studies	153	13.7	26.1	19.6	32.7	7.8
Organising a suitable timetable, with no clashes, was challenging	152	20.4	34.9	17.1	18.4	9.2
I couldn't get help when I needed it	150	19.3	37.3	16.7	18.0	8.7
The University staff were not friendly	151	25.2	35.8	21.9	11.9	5.3
The University facilities were not adequate	152	23.7	43.4	18.4	10.5	3.9
There were no opportunities to socialise	151	19.9	39.7	27.2	9.3	4.0
Attending evening classes posed a security risk	152	38.8	38.2	19.1	3.3	0.7

Table 1 Responses to reasons for attrition associated with the university environment (SD = Strongly Disagree to SA = Strongly Agree)

The most frequent response to the reasons relating to the course experience (Table 2) was that classes were boring (42.4% agreement). Many also found the pace of teaching too fast (32.2% agreement). As one of the participants put it:

> *"It was uninteresting and not exciting. I felt like I was just memorising information, not using critical thinking, not *really* learning" Male, 19, IT.*

Course Experience Reasons	Total Num.	SD %	D %	N %	A %	SA %
Teaching						
The classes were boring	151	9.9	27.8	19.9	25.8	16.6
The pace of teaching was too fast	152	17.1	33.6	17.1	20.4	11.8
The teachers didn't explain the exercises	151	13.9	38.4	19.2	19.9	8.6
I wasn't encouraged to do well by the teachers	151	15.2	34.4	27.8	16.6	6.0
The teaching methods were harsh and confrontational	152	20.4	43.4	24.3	10.5	1.3
The teachers were not prepared	152	18.4	51.3	20.4	5.9	3.9
The teachers' knowledge was out of date	152	15.1	44.1	25.0	11.8	3.9
Course						
The course didn't have a workplace focus	151	9.9	27.2	25.8	25.8	11.3
The course lacked practical applications	151	12.6	39.1	17.2	19.9	11.3
The course didn't have a business focus	152	14.5	26.3	28.3	21.7	9.2
The course was too theoretical	152	13.8	34.9	22.4	22.4	6.6
The course was poorly structured	149	12.8	34.9	25.5	15.4	11.4
There were too many assignments	147	13.6	36.7	27.9	18.4	3.4
The focus was on individual activities rather than groups	149	18.1	32.2	30.2	13.4	6.0
The course was too mathematical	151	15.9	46.4	19.2	12.6	6.0
Teaching and learning environment						
Academic environment did not suit my learning style	152	13.2	32.9	18.4	23.7	11.8
I didn't feel I fitted in or belonged	147	18.4	27.9	17.7	24.5	11.6
The teaching environment was not welcoming	152	15.1	38.2	21.1	17.1	8.6
I was in the minority in my classes	146	24.7	32.2	17.8	16.4	8.9
The course was too competitive	151	17.9	40.4	28.5	11.9	1.3
Preparedness and other student issues						
The course didn't meet my expectations	148	8.8	20.9	16.9	30.4	23.0
I didn't enjoy attending classes	146	12.3	18.5	19.9	32.9	16.4
I didn't understand the concepts	152	17.1	33.6	15.8	24.3	9.2
My results were not as high as I expected	149	12.1	29.5	28.9	22.1	7.4
I didn't make friends with classmates	145	15.2	33.8	24.1	17.9	9.0
I didn't understand the meaning of the terms used in the course	149	18.8	40.3	18.1	20.1	2.7
I didn't have the expected background knowledge	148	23.6	35.1	16.2	15.5	9.5
I felt it was unacceptable to be smart	147	36.7	44.2	14.3	4.8	0.0

Table 2: Responses to reasons for attrition associated with the course experience (SD = Strongly Disagree to SA = Strongly Agree)

In a recent Australian survey of over 30,000 students, ICT students were found to have the lowest levels of academic challenge, higher order thinking and enriching educational experiences of all disciplines considered (ACER, 2010). The results of the current study reflect a sense that much ICT teaching may be boring because of its focus on transferring content knowledge at a rapid rate rather than making use of constructivist approaches; this is contributing to attrition.

Consistent with perceptions that ICT teaching can be boring, other frequent course experience reasons were: the balance between application and theory; lack of workplace focus (37.1% agreement), lack of practical applications (31.2% agreement) and lack of business focus (20.9% agreement). Courses were also seen as too theoretical (29.0% agreement). ICT courses in Australia have the lowest proportion of students doing internships (ACER, 2010), and a study by Koppi et al. (2010) noted that ICT graduates in the workplace have recommended that students receive more industry related learning. Weng et al. (2010) also called for an increased focus on solving business problems. The following quote from a participant reflects a common sentiment among students:

> *"I lost interest in IT through the university's conception of what IT is. It was presented as highly technical, highly mathematical and very individualized. In reality, IT has close links with business, work in teams and programming is a small portion of what IT is about." Male, 17, IT.*

Issues associated with the teaching and learning environment were also considered important: some felt that the teaching environment did not suit their learning style (35.5%), or was not welcoming (25.7%) and 36.1% felt that they did not belong. Barker et al.'s (2009) study of predictors of intention to persist in computer science found that when students perceive the workload as being too heavy they are less likely to pursue the major. While this influenced some students (21.8%) it was not the major issue.

Participants also noted reasons such as the course not meeting their expectations (53.4% agreement) and not enjoying classes (49.3% agreement). These sentiments are relatively general and could be associated with a variety of other more specific reasons discussed in this section.

Some students felt that they did not understand the concepts (33.5%), or terms used in the course (22.8%) and believed that they did not have the expected background knowledge (26.9%). This perception is illustrated by the following quote:

> *I didn't have the expected background knowledge; the courses were definitely geared towards those with more pre-existing knowledge. Female, 18, IT.*

Having the expected background for ICT studies has been identified in previous research as an important predictor of attrition (Barker et al., 2009). This issue is explored further below in relation to different types of students.

The social aspect of study also received attention with 26.9% of participants agreeing that they didn't make friends with classmates. For example:

> *"During the tutorials there was no chance or encouragement to socialise with other students." Male, 17, Games Software Design.*

This was also identified by Barker et al. (2009), who found that levels of student-to-student interaction were perceived as 'unfavourable' by the computer science students in their study, and they recommended that faculty focus on incorporating activities that support interaction. This issue can be addressed in both the nature of the course and in the teaching approaches used.

The responses to possible reasons for attrition that relate to the lives of the students are shown in Table 3. Many participants felt that they had picked the wrong degree (43.7% agreement). This sentiment implies a lack of interest and engagement with the degree content, but could also be associated with a variety of other more specific reasons that are discussed in this section.

Financial pressures are of concern to students in all disciplines, and a major predictor of attrition (Bennett, 2003; Cabrera et al., 1993). ICT students are no different in this respect. The cost of university education influenced many of the participants. It was considered too expensive by over a third (37.3%) and 19.8% agreed or strongly agreed that they couldn't get financial aid. Conflicts with work commitments were also a common issue; 36.4% agreed that they experienced conflict with work commitments, and 33.4% noted that their study timetable did not fit with their work commitments. Various aspects of travel to university were also found to be problematic for many: distance was an issue for 24.9%, and transport availability for 23.5%. Factors such as these make it difficult for students to fully engage with their studies and are likely to work in combination with other issues to precipitate attrition as illustrated by the following quote:

> *"Finances were a big issue; Public transport from the southern highlands was almost nonexistant, thus I had to drive - petrol was costing me greatly. To make the money to get to uni, I had to spend all my 'spare' time working, which of course meant I had no time for uni. Stress of both money and failing classes compounded, making both problems even worse." Male, 18, IT.*

Life Experience Reasons	Total Num.	SD %	D %	N %	A %	SA %
I picked the wrong degree	144	18.1	17.4	20.8	20.8	22.9
Attending university was too expensive	142	23.9	21.8	16.9	21.1	16.6
There was conflict with my work commitments	143	26.6	23.1	14.0	21.0	15.4
My timetable didn't fit with my work commitments	144	22.2	25.0	19.4	17.4	16.0
Travelling to University was/is difficult because of distance	145	31.7	25.5	17.9	15.2	9.7
Travelling to University was/is difficult because of transport	145	30.3	29.0	17.2	14.5	9.0
I couldn't get financial aid	141	32.6	25.5	22.0	9.2	10.6
My timetable didn't fit with the transport timetable	143	30.8	29.4	25.2	9.8	4.9
My family didn't help me to study at home	144	37.5	25.7	23.6	9.7	3.5
Living at home was too difficult	145	33.1	31.0	26.9	6.2	2.8
I became very ill or was involved in a serious accident	145	47.6	24.8	19.3	4.8	3.4
Studying at University wasn't as important as socialising with my friends	144	34.0	37.5	20.8	6.3	1.4
Living away from home was too difficult	144	31.9	26.4	33.3	2.8	5.6
A family member died or was very ill or had a serious accident	144	50.7	25.0	17.4	4.2	2.8
I lost my job	143	48.3	25.2	21.0	3.5	2.1
I missed my family	144	34.7	32.6	27.8	3.5	1.4
I or my partner got pregnant.	144	52.1	20.1	23.6	2.8	1.4
Living in student accommodation was too difficult	142	26.8	21.1	47.9	3.5	0.7

Table 3: Responses to reasons associated with students and their lives (SD = Strongly Disagree to SA = Strongly Agree)

Few ex-students indicated that they had been affected by serious illness (8.2%), death or illness in the family (7.0%), loss of their job (5.6%) or pregnancy of themselves or their partner (4.2%).

The results above demonstrate the wide range of issues that can contribute to student attrition. Figure 1 summarises the dominant reasons, that is, those that received 25% or higher agreement from the participants.

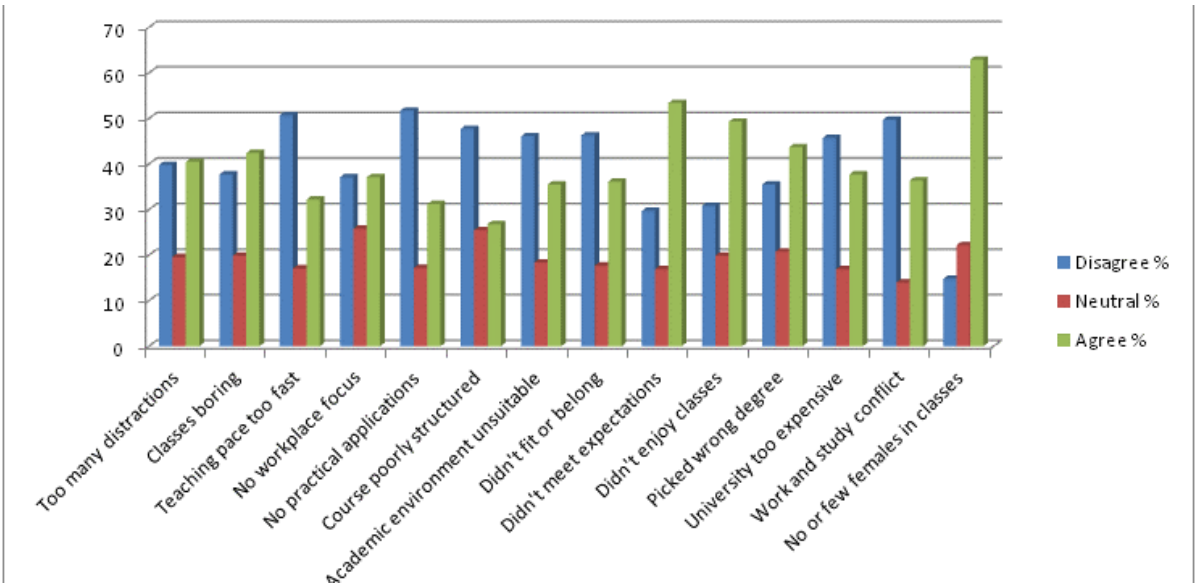

Figure 1: Dominant reasons for leaving ICT courses

It appears that individual students rarely withdraw from their studies for just one reason. Personal issues and university and course related issues combine to put pressure on students who may respond by ceasing their studies. In some cases ex-students feel they have made the decision willingly, but in others they are very conscious of the lack of support received, as illustrated by the following quotes:

> *"I found the attitude of the faculties, the structure of courses and resistance to reasonable student requests very deflating and negative" Male, 21, Comp Eng.*

> *"Was not provided with enough information about how I should have acted when I got very sick, and even though I handed in withdrawal forms, was treated unfairly when it took staff 3 months after constant hassling by me to get information, and in result still getting charged and not withdrawn from my subjects". Male, 18, IS.*

3.3 Do Different Types of Students have Different Reasons for Leaving their ICT Course?

Various student characteristics have been proposed to influence attrition; these include gender, age, and enrolment status (Barker et al., 2009; Long et al., 2006). Nonparametric Mann-Whitney U tests were used to determine whether these factors had a significant influence on students' reasons for leaving their ICT course. This test was used as an alternative to independent samples t-tests to ensure that violations of the assumptions did not impact on the interpretation of the results. A significance level of $p < 0.05$ was established. Tables 5 to 7 provide the mean agreement ratings for each subgroup for those reasons where there was a significant difference.

3.3.1 Gender Differences

The first demographic factor considered was gender. Summary attrition data for the four universities involved in the study (Department of Education Employment and Work Relations, 2011), suggested that females students, once enrolled, were not more likely to withdraw from their course than male students. Their reasons for withdrawal may, however, differ and this is explored below.

Several possible reasons for attrition relating specifically to gender issues were included in the survey. The levels of agreement of the 29 female participants are reported in Table 4 below. Overall, gender issues did not appear to be relatively important to the female respondents. Whilst the gender imbalance was certainly noted (62.9% agreement), sexist behaviour from male staff or students was not rated highly as an issue in terms of their withdrawal from the course. For example, only one female participant agreed that male students or staff spoke in a sexist manner, or that male students did not let them participate. Some female participants (18.5%) felt that male staff did not encourage them to participate, and 27.6% believed that the course content was male oriented. The levels of agreement with these issues were however not significantly different from those of the male ex-students ($U=1405.5$, $Z=-1.16$, $p=0.259$; $U=1466.0$, $Z=-1.55$, $p=0.120$). The general sentiment is encapsulated by the following comments:

> *''As a female, I guess it was easier to quit because it "just wasn't my thing". It had nothing to do with anyone in particular, just that most of the course were males" Female, 17, IT.*

> *"Just because I'm a female doesn't mean anything. Most of my friends are guys so I don't mind being one of the only girls." Female, 18, Network Design.*

> *"As a female it was quite daunting being a minority in the class but the male students and teachers were in no way deliberately sexist." Female, 17, IT.*

Gender Specific Reasons	Total Num.	SD %	D %	N %	A %	SA %
There were no or few females in the classes	27	11.1	3.7	22.2	48.1	14.8
The course content was male oriented	29	20.7	24.1	27.6	20.7	6.9
Students acted or spoke in a sexist manner	28	28.6	32.1	32.1	3.6	3.6
Male students wouldn't let me participate	27	25.9	40.7	29.6	3.7	0.0
Male staff didn't encourage me to participate	27	25.9	33.3	22.2	18.5	0.0
Male staff acted or spoke in a sexist manner	27	33.3	37.0	25.9	0.0	3.7

Table 4: Female participant responses to gender specific reasons for leaving an ICT course (SD = Strongly Disagree to SA = Strongly Agree)

Gender was found to have a significant influence on students' agreement with several of the other possible reasons for leaving their ICT course, as shown in Table 5. Males were significantly more likely to believe that there were too many distractions preventing them from concentrating on their studies (U=1316.0, Z=-2.32, p=0.020). Females, on the other hand, were more likely to believe that they didn't have the expected background knowledge for the course (U=1240.0, Z=-2.23, p=0.026), didn't understand the concepts U=995.5, Z=-3.63, p<0.001), or didn't understand the meaning of terms used in the course (U=1243.0, Z=-2.29, p=0.022). Previous research has suggested that female students have no less ability to undertake ICT courses than male students (Beyer et al., 2003), however, it has been found that female ICT students lack confidence in their ability to achieve their educational goals (Beyer et al., 2003; Cohoon, 2007). The findings of this study are consistent with this previous research. Lack of confidence in ability to undertake study in a discipline that is perceived to be challenging is thought to contribute to low enrolment rates of females (Gras-Velazquez et al., 2009; Manis et al., 1989). It also appears to contribute to female attrition, preventing female students from accessing the benefits that can flow from an ICT career. Actions that increase confidence should be pursued. These might include mentoring (Cohoon, 2001) and early exposure to work integrated learning.

Female ex-students were also more likely to say that their results were not as high as they had expected (U=1244.5, Z=-2.26, p=0.024), and that they felt they had picked the wrong degree (U=1189.5, Z=-2.04, p=0.041). Previous research has shown that female students who leave ICT degrees tend to have higher grades than males students who do not leave (Strenta et al., 1994), yet they are more sensitive to perceptions that their grades are lower than those they received in high school (Jagacinski et al., 1988). Differential attrition of female students in this way is a major loss to the ICT profession, but it is not purely a gender issue, as Strenta et al. (1994) found that in other disciplines, such as science and engineering, where persistence was the same grades were the same.

Given that there is a common perception that women are more likely to take on caring roles that ensure the functioning of families than males, it might have been expected that female ex-students would have shown stronger agreement with reasons relating to life issues. Unexpectedly, there were no significant differences in responses to most of the life issues: female students were not more likely to be affected by issues such as pregnancy or dealing with family illness.

Reasons	Females		Males		
	Mean	Std. dev.	Mean	Std. dev.	Sign.
There were too many distractions preventing me from concentrating on my studies	2.48	1.06	3.06	1.22	0.020
I didn't understand the concepts	3.54	1.17	2.57	1.21	<0.001
I didn't have the expected background knowledge	3.00	1.30	2.41	1.24	0.026
I didn't understand the meaning of the terms used in the course	2.96	1.29	2.36	1.02	0.022
My results were not as high as I expected	3.29	1.15	2.73	1.10	0.024
I was in the minority in my classes	3.04	1.26	2.41	1.25	0.018
I picked the wrong degree	3.63	1.36	3.02	1.41	0.041

Table 5: Reasons for attrition with significantly different levels of agreement between females and males

3.3.2 Full Time versus Part Time Study

The majority of previous research has focussed on students who were studying full time (e.g. Braxton et al., 2000; Christie et al., 2004; Crisp et al., 2009; Harrison, 2006; Price et al., 1992; Stratton et al., 2008). However, many students study part time in order to be able meet their work or family commitments, and previous research has shown that part time students are more likely to withdraw from their studies (Bean & Metzner, 1985; Long et al., 2006). It might be expected that part time students face greater pressures, so differences in their reasons for ceasing to study are of interest.

As shown in Table 6, participants who had been full time students differed significantly from those who had been part time in their levels of agreement with many of the reasons for attrition. In all except two cases, students who had been full time had stronger levels of agreement. This included all differences relating to perceptions of the university environment and the course and how it was taught, and all but two of the reasons associated with the lives of the students. For example, full time students were significantly more likely to

believe that they had picked the wrong degree (U=1200.5, Z=-3.89, p<0.001), that classes were boring (U=1441.5, Z=-3.24, p=0.001), and that they did not have sufficient background (U=1684.5, Z=-2.12, p=0.034) or understand the concepts (U=1520.0, Z=-3.11, p=0.002). This finding is surprising. Traditionally part time students have been perceived as facing significant pressures associated with juggling the competing demands of work, family and study; whereas full time students have been viewed as having more freedom to devote their time and attention to their studies. This is perhaps no longer the case. Analysis of the hours worked by the participants who were full time students before they withdrew showed that 59.4% were working over 10 hours per week, and 27.7% were working over 20 hours per week. This suggests that in some respects full time students may be under greater pressure than part time students, and that this has led to an increased sensitivity to a range of issues that affect their satisfaction with their studies and predispose them to attrition.

The two issues with which students who had been part time were more likely to agree related to conflicts between their studies and their work commitments. This is consistent with Long et al.'s (2006) findings and summarised by the following quote:

> *"Financial struggle. I was unable to support my family while attending University Full Time. I tried going part time but this was still too hard. I tried external, however working full time and then trying to study all became too stressful"* Male, 25, CS.

Reasons	Full time		Part time		
	Mean	Std. dev.	Mean	Std. dev.	Sign.
University environment					
Academic environment did not suit my learning style	3.07	1.18	2.35	1.31	0.001
I couldn't get help when I needed it	2.75	1.23	2.15	1.14	0.008
The university staff were not friendly	2.51	1.17	1.92	0.91	0.006
Course/teaching					
The pace of teaching was too fast	2.96	1.28	2.21	1.15	0.001
The classes were boring	3.31	1.22	2.54	1.23	0.001
The teachers didn't explain the exercises	2.85	1.20	2.31	1.06	0.018
The course was too competitive	2.50	0.99	2.05	0.78	0.013
The course was too theoretical	2.93	1.10	2.17	1.11	<0.001
I didn't understand the concepts	2.94	1.25	2.23	1.12	0.002
The course was too mathematical	2.65	1.12	1.95	0.78	<0.001
I didn't have the expected background knowledge	2.66	1.30	2.15	1.12	0.034
The course was poorly structured	2.94	1.18	2.33	1.14	0.003
The course didn't meet my expectations	3.53	1.25	2.98	1.31	0.021
I didn't understand the meaning of the terms used in the course	2.62	1.10	2.08	0.97	0.006
There were too many assignments	2.76	1.07	2.21	0.86	0.005
I didn't feel I fitted in or belonged	3.00	1.31	2.38	1.19	0.011
I didn't enjoy attending classes	3.47	1.20	2.58	1.24	<0.001
Life					
I picked the wrong degree	3.41	1.40	2.38	1.18	<0.001
My timetable didn't fit with my work commitments	2.61	1.28	3.31	1.56	0.012
There was conflict with my work commitments	2.56	1.30	3.28	1.67	0.015
My timetable didn't fit with the transport timetable	2.42	1.20	1.92	0.93	0.033
Studying at University wasn't as important as socialising with my friends	2.15	0.99	1.72	0.82	0.016

Table 6: Reasons for attrition with significantly different levels of agreement between participants who were full time and those that were part time

3.3.3 Age Differences

There is some evidence that, in general, older students are more likely to cease their study (Department of Education Science and Training, 2004). Whether this is the case for ICT students, and if so why, was explored here. Table 7 lists the reasons for attrition where there were significant differences in agreement between participants who were 20 or younger when they enrolled and those who were 21 or older. Again the findings were surprising as for all but four of the proposed reasons for attrition, where differences were significant, the younger group showed higher levels of agreement. This included all differences relating to University Experience Reasons and Course Experience Reasons and all but three of the Life Experience Reasons. Three of the reasons with which the older students showed higher levels of agreement were pregnancy of themselves or their partner (U=1964.0, Z=-2.74, p=0.006), loss of their job (U=2090.5, Z=-2.02, p=0.043), and death or serious illness in the family (U=3234.5, Z=-2.79, p=0.005). These are serious life events that are often linked to stage of life, so the differences are what might be expected. The older students also agreed more that university was too expensive (U=1991.5, Z=-2.20, p=0.028). Older students are less likely to receive parental support and more likely to be supporting others and incurring large expenses such as home mortgages, hence this difference is not surprising. The higher levels of agreement by younger students with many course related issues such as classes being boring (U=1622.5, Z=-4.68, p<0.001), the pace of teaching being too fast (U=2279.5, Z=-2.30, p=0.022), and the course having too many assignments (U=2111.0, Z=-2.38, p=0.017) perhaps suggests that older students had made a more considered choice when starting their ICT course and that, whilst life issues influenced their decisions, they were less susceptible to other issues.

Reasons	20 or under		21 or over		
	Mean	Std. dev.	Mean	Std. dev.	Sign.
Course/teaching					
Academic environment did not suit my learning style	3.08	1.16	2.68	1.32	0.038
The pace of teaching was too fast	3.00	1.13	2.51	1.22	0.022
The classes were boring	3.58	1.16	2.62	1.19	<0.001
The teachers didn't explain the exercises	2.95	1.19	2.44	1.14	0.010
The course was too competitive	2.54	0.98	2.22	0.92	0.040
The course was too theoretical	2.96	1.33	2.49	1.13	0.011
I didn't understand the concepts	3.15	1.28	2.32	1.09	<0.001
The course was too mathematical	2.66	1.12	2.26	1.02	0.015
The course didn’t have a business focus	3.05	1.27	2.64	1.07	0.034
I didn't have the expected background knowledge	2.78	1.37	2.26	1.11	0.023
The course didn't meet my expectations	3.65	1.23	3.11	1.29	0.010
I didn’t understand the meaning of the terms used in the course	2.71	1.16	2.24	0.98	0.015
There were too many assignments	2.82	1.08	2.41	0.96	0.017
My results were not as high as I expected	3.04	1.13	2.62	1.09	0.040
I didn't feel I fitted in or belonged	3.10	1.34	2.57	1.22	0.016
I didn't enjoy attending classes	3.83	1.05	2.64	1.20	<0.000
Life					
I or my partner got pregnant	1.58	0.84	2.04	1.07	0.006
There was conflict with my work commitments	2.44	1.30	3.09	1.51	0.009
I lost my job	1.69	0.93	2.03	1.06	0.043
A family member died or was very ill or had a serious accident	1.62	0.95	2.06	1.08	0.005
Attending university was too expensive	2.58	1.43	3.10	1.37	0.028
I picked the wrong degree	3.77	1.30	2.48	1.24	<0.000

Table 7: Reasons for attrition with significantly different levels of agreement between participants who were 20 or younger when they enrolled and those who were 21 or older

4. SUMMARY AND CONCLUSIONS

Student attrition is an issue of serious concern to universities around the world. It is of particular concern to the field of ICT because of the shortfall of ICT professionals (ACS, 2008). The study described in this paper has attempted to further understand the causes of attrition from ICT courses by exploring the reasons students from four Australian universities gave for leaving their ICT courses.

This study has shown there are many factors that can contribute to the attrition of ICT students, and for many students it is a combination of issues that leads to their withdrawal. Some of these issues are beyond the control of universities but many could be mitigated by universities taking appropriate action.

Only a relatively small number of ex-students had experienced serious life events (such death or serious injury in the family, pregnancy, or loss of their employment) that necessitated their withdrawal. It was much more common for the participants to cite reasons associated with the university environment, the teaching of their ICT course, and their inability to combine their studies with other commitments. A theme in issues associated with the university environment was the difficulty in obtaining help when required. The transition from school to university is a challenging one, and providing greater levels of support during the initial enrolment process, and when students need to makes changes to their enrolment to accommodate other changes in their lives, would address a number of the factors that students have indicated influenced their decision to withdraw. In particular, issues relating to financial pressures, and the attendant conflicts with other commitments that arise when students need to support themselves, require a sympathetic ear and help with strategies to manage the challenges of scheduling study around work commitments and managing transportation issues. These issues are particularly important for students who are older and/or studying part time.

The major course related issues that contributed to withdrawal were related to the style of teaching and to the focus of the ICT course. Many ex-students had found their classes boring, yet they also noted that the pace of teaching was often too fast, and exercises were not explained well. These sentiments have also been expressed by students who continue with their ICT course, resulting in ICT courses being ranked as having the lowest levels of enriching educational experiences and higher order thinking of all courses considered in survey of over 30,000 students (ACER, 2010). The way in which ICT is taught clearly requires urgent consideration. Recommendations from the ICT education literature include increasing the use of small group class activities (Barker et al., 2009; Powell, 2008). Small group activities provide students with opportunities to undertake more active learning, addressing the boredom issue (Schweitzer & Brown, 2007), but also to increase levels of interaction with other students and faculty. Increasing this interaction reduces the likelihood of students feeling disconnected from the teaching and learning environment and makes it easier for them to ask for support when they need it.

In addition to the style of teaching, the balance between application and theory was also of concern. Courses were seen to lack a workplace or business focus and to lack practical application. This finding is not just applicable to students who withdraw; students who have successfully completed their course and obtained work in the ICT industry have also called for more industry related learning (Koppi et al., 2010). Increased use of case based teaching can tie ICT content to application, enabling students to understand the context in which their knowledge will be applied (Mukherjee, 2000; Weng et al., 2010). Better integration of practical and workplace knowledge and skills can also be achieved though providing forms of work integrated learning (e.g. industry related projects or work placements). Team based projects that address problems or opportunities provided by companies, government departments or community organisations enable students to gain professional skills while ensuring that curriculum is aligned with industry needs. Work placements (or internships) are another way to provide students with valuable experience and to strengthen their sense of the relevance of their ICT course. Addressing the perceived lack of workplace focus will lead to committed students who can see where their ICT degree is taking them, possibly providing a greater incentive to work through issues that might be making students consider withdrawing.

Some students' decisions about withdrawal were influenced by a perception that they did not have the expected background knowledge. Previous ICT experience has been found to be an important predictor of attrition (Barker et al., 2009). This issue can be successfully addressed by implementing alternate pathways, so that those students without a strong background take an alternative initial unit in their first year that provides the opportunity to develop the skills and confidence to be successful. This approach has been shown to be particularly valuable in addressing the attrition of female students, as they are more likely to believe that they do not have the necessary background (Powell, 2008). Other strategies that have had success in

improving female student retention include ensuring a gender balance in faculty and providing mentoring (Cohoon, 2001).

5. REFERENCES

ACER (2010). *Doing More for Students: Enhancing Engagement and Outcomes*, from http://ausse.acer.edu.au/images/docs/AUSSE_2009_Student_Engagement_Report.pdf.

ACS (2008). *The ICT Skill Forecast Project. First Report: Quantifying Current and Forecast ICT Employment*, from http://www.acs.org.au/attachments/ICTSkillsForecastingReportExecSummaryAug08.pdf.

Andrew, S., Salamonson, Y., Weaver, R., Smith, A., O'Reilly, R., & Taylor, C. (2007). Hate the Course or Hate to Go: Semester Differences in First Year Nursing Attrition. *Nurse Education Today, 28*, 865-872.

Bailey, M., & Borooah, V. K. (2007). *Staying the Course: An Econometric Analysis of the Characteristics Most Associated with Student Attrition Beyond the First Year of Higher Education*. from http://www.delni.gov.uk/staying_the_course.pdf.

Barker, L. J., McDowell, C., & Kalahar, K. (2009). Exploring Factors that Influence Computer Science Introductory Course Students to Persist in the Major. *SIGCSE Bulletin, 41*(2), 282-286.

Bean, J. P. (1980). Dropouts and Turnover: The Synthesis and Test of a Causal Model of Student Attrition. *Research in Higher Education, 12*(2), 155-187.

Bean, J. P., & Metzner, B. S. (1985). A Conceptual Model of Nontraditional Undergraduate Student Attrition. *Review of Educational Research, 55*(4), 485-540.

Beekhoven, S., De Jong, U., & Van Hout, H. (2002). Explaining Academic Progress Via Combining Concepts of Integration Theory and Rational Choice Theory. *Research in Higher Education, 43*(5), 577-600.

Bennett, R. (2003). Determinants of Undergraduate Student Drop Out Rates in a University Business Studies Department. *Journal of Further and Higher Education, 27*(2), 123-141.

Beyer, S., Rynes, K., Perrault, J., Hay, K., & Haller, S. (2003). Gender Differences in Computer Science Students. *SIGSE Bulletin, 35*(1), 49-53.

Braxton, J., Milem, J. F., & Sullivan, A. S. (2000). The Influence of Active Learning on the College Student Departure Process: Toward a Revision of Tinto's Theory. *The Journal of Higher Education, 71*(5), 569-590.

Cabrera, A. F., Nora, A., & Castaneda, M. B. (1993). College Persistence: Structural Equations Modeling Test of an Integrated Model of Student Retention. *The Journal of Higher Education, 64*(2), 123-139.

Christie, H., Munro, M., & Fisher, T. (2004). Leaving University Early: Exploring the Differences Between Continuing and Non-continuing Students. *Studies in Higher Education, 29*(5), 617-636.

Cohoon, J. M. (2001). Toward Improving Female Retention in Computer Science. *Communications of the ACM, 44*(5), 108-114.

Cohoon, J. M. (2007). Gendered Experiences of Computing Graduate Programs. *SIGCSE Bulletin, 39*(1), 546-550.

Cohoon, J. M., & Aspray, W. (Eds.). (2006). *Women and Information Technology: Research on Underrepresentation*. Cambridge, Mass: Massachusetts Institute of Technology Press.

Computing Research Association (2008). 2006-2007 Taulbee Survey: Ph.D. Production Exceeds 1,700; Undergraduate Enrollment Trends Still Unclear, from http://www.cra.org/CRN/articles/may08/taulbee.html

Cory, S. N., Parzinger, M. J., & Reeves, T. E. (2006). Are High School Students Avoiding the Information Technology Profession Because of the Masculine Stereotype? *Information Systems Education Journal, 4*(29), 3-13.

Craig, A., Fisher, J., & Lang, C. (2007). ICT and Girls: The Need for a Large-Scale Intervention *Proceedings of the 18th Australasian Conference on Information Systems*. Toowoomba, Australia.

Craig, A., Paradis, R., & Turner, E. (2002). A Gendered View of Computer Professionals: Preliminary Results of a Survey. *SIGCSE Bulletin, 34*(2).

Crisp, G., Nora, A., & Taggart, A. (2009). Student Characteristics, Pre-college, College, and Environmental Factors as Predictors of Majoring in and Earning a STEM Degree: An Analysis of Students Attending a Hispanic Serving Institution. *American Educational Research Journal, 46*(4), 924-942.

Department of Education Employment and Work Relations (2011). *Students, Selected Higher Education Statistics* (No. RFI 10-324 Roberts)

Department of Education Science and Training (2004). *Higher Education Attrition Rates 1994 - 2002: A Brief Overview*.

e-skills UK (2011). Technology Insights 2011: Key findings, from http://www.e-skills.com/Research/Research-publications/Insights-Reports-and-videos/Technology-Insights-2011/Technology-Insights-2011-Key-findings/.

Frieze, C. (2005). Diversifying the Images of Computer Science: Undergraduate Women take on the Challenge! *SIGCSE Bulletin, 37*(1), 397-400.

Granger, M., Dick, G., Jacobson, C., & Slyke, C. (2007). Information Systems Enrollments: Challenges and Strategies. *Journal of Information Systems Education, 18*(3), 303-311.

Gras-Velazquez, A., Joyce, A., & Debry, M. (2009). *Women and ICT: Why are Girls Still not Attracted to ICT Studies and Careers?* , from http://blog.eun.org/insightblog/upload/Women_and_ICT_FINAL.pdf.

Harrison, N. (2006). The Impact of Negative Experiences, Dissatisfaction and Attachment on First Year Undergraduate Withdrawal. *Journal of Further and Higher Education, 30*(4), 377-391.

Hinton, L. (2007). Causes of Attrition in First Year Students in Science Foundation Courses and Recommendations for Intervention. *Studies in Learning, Evaluation, Innovation and Development, 4*(2), 13-26.

Hovdhaugen, E. (2009). Transfer and Dropout: Different Forms of Student Departure in Norway. *Studies in Higher Education, 34*(1), 1-17.

ITU (2010). New ITU report Shows Global Uptake of ICTs Increasing, Prices Falling, from http://www.itu.int/newsroom/press_releases/2010/08.html.

Jagacinski, C. M., Lebold, W. K., & Salvendy, G. (1988). Gender Differences in Persistence in Computer-Related Fields. *Journal of Educational Computing Research, 4*(2), 185-202.

Johnes, G., & McNabb, R. (2004). Never Give Up on the Good Times: Student Attrition in the UK. *Oxford Bulletin of Economics and Statistics, 66*(1), 23-47.

Koppi, T., Edwards, S. L., Sheard, J., Naghdy, F., & Brookes, W. (2010). The Case for ICT Work-Integrated Learning from Graduates in the Workplace. In T. Clear & J. Hamer (Eds.), *Proceedings of the Twelfth Australasian Conference on Computing Education (ACE '10)* (pp. 107-116). Darlinghurst, Australia.

Koppi, T., & Naghdy, F. (2009). Managing Educational Change in the ICT Discipline at the Tertiary Education Level, from http://www.altc.edu.au/system/files/resources/DS6-600%20Managing%20educational%20change%20in%20the%20ICT%20discipline%20March%202009.pdf.

Lewis, S., Lang, C., & McKay, J. (2007). An Inconvenient Truth: The Invisibility of Women in ICT. *Australasian Journal of Information Systems, 15*(1), 59-76.

Lewis, T. L., Smith, W. J., Belanger, F., & Harrington, K. V. (2008). Are Technical and Soft Skills Required?: The Use of Structural Equation Modeling to Examine Factors Leading to Retention in the CS Major *Proceedings of the Fourth International Workshop on Computing Education Research (ICER '08)*: ACM.

Long, M., Ferrier, F., & Heagney, M. (2006). *Stay, Play or Give it Away? Students Continuing, Changing or Leaving University Study in their First Year*. Clayton, Victoria, Australia, from http://www.dest.gov.au/NR/rdonlyres/678FF919-3AD5-46C7-9F57-739841698A85/14398/final.pdf.

Manis, J., Sloat, B. F., Thomas, N. G., & Davis, C. S. (1989). *An Analysis of Factors Affecting Choices of Majors in Science, Mathematics and Engineering at the University of Michigan*. Ann Arbor Michigan: Center for the Education of Women, University of Michigan.

Mann, S., & Robinson, A. (2009). Boredom in the Lecture Theatre: An Investigation into the Contributors, Moderators and Outcomes of Boredom Amongst University Students. *British Educational Research Journal, 35*(2), 243-258.

Marandet, E., & Wainwright, E. (2009). Invisible Experiences: Understanding the Choices and Needs of University Students with Dependent Children. *British Educational Research Journal*, 1-19.

Marginson, S., Nyland, C., Sawir, E., & Forbes-Mewett, H. (2010). *International Student Security*. Melbourne: Cambridge University Press.

Marks, G. (2007). *Completing University:Characteristics and Outcomes of Completing and Non-completing Students*, from http://research.acer.edu.au/lsay_research/55.

McMillan, J. (2005). *Course Change and Attrition from Higher Education*. from http://tls.vu.edu.au/sls/slu/FOR_STAFF/Staff_Resources/research%20papers%201%20(national)/Course%20Change%20and%20Attrition%20from%20Higher%20Education.pdf.

Mukherjee, A. (2000). Effective Use of In-class Mini Case Analysis for Discovery Learning in an Undergraduate MIS Course. *Journal of Computer Information Systems, 40*(3), 15-23.

Ogan, C., Robinson, J. C., Ahuja, M., & Herring, S. C. (2006). Gender Differences Among Students in Computer Science and Applied Information Technology. In J. M. Cohoon & W. Aspray (Eds.), *Women and Information Technology: Research on Underrepresentation*. Cambridge, Massachusetts: Massachusetts Institute of Technology Press.

Powell, R. M. (2008). Improving the Persistence of First-Year Undergraduate Women in Computer Science. *SIGCSE Bulletin, 40*(1), 518-522.

Price, D., Harte, J., & Cole, M. (1992). *Student Progression in Higher Education: A Study of Attrition at Northern Territory University*. Canberra: Australian Government Publication Service.

Schweitzer, D., & Brown, W. (2007). Interactive visualization for the active learning classroom. *SIGCSE Bulletin, 39*(1), 208-217.
Seidman, A. (Ed.). (2005). *College Student Retention: Formula for Student Success*. Westport, Connecticut: Praeger.
Siann, G., & Callaghan, M. (2001). Choices and Barriers: Factors Influencing Women's Choice of Higher Education in Science, Engineering and Technology. *Journal of Further and Higher Education, 25*(1), 85-95.
Stater, M. (2009). The Impact of Financial Aid on College GPA at Three Flagship Public Institutions. *American Educational Research Journal, 46*(3), 782-815.
Stratton, L. S., O'Toole, D. M., & Wetzel, J. N. (2008). A Multinomial Logit Model of College Stopout and Dropout Behavior. *Economics of Education Review, 27*, 319-331.
Strenta, A. C., Elliott, R., Adair, R., Matier, M., & Scott, J. (1994). Choosing and Leaving Science in Highly Selective Institutions. *Research in Higher Education, 35*(5), 513-547.
Telecompaper (2010). Number of ICT workers in Germany at record levels *Telecompaper* Retrieved 19 Oct, from http://www.telecompaper.com/news/number-of-ict-workers-in-germany-at-record-levels-bitkom
Tinto, V. (1975). Dropout from Higher Education: a Theoretical Synthesis of Recent Research. *Review of Educational Research, 45*(1), 89-125.
Tinto, V. (1993). *Leaving College: Rethinking the Causes and Cures of Student Attrition* (2nd ed.). Chicago: University of Chicago Press.
Weng, F., Cheong, F., & Cheong, C. (2010). Modelling IS Student Retention in Taiwan: Extending Tinto and Bean's Model with Self-Efficacy. *ITALICS, 9*(2).
Yorke, M. (1998). Non-completion of Undergraduate Study: Some Implications for Policy in Higher Education. *Journal of Higher Education Policy and Management, 20*(2), 189-201.

ACKNOWLEDGEMENTS
This research was supported by an ALTC Priority Project grant. The following additional project team members contributed to the survey design: Philip Ogunbona and Fazel Naghdy (University of Wollongong); Jocelyn Armarego (Murdoch University); Chris Pilgrim (Swinburne University of Technology); and Paul Bailes (University of Queensland).